DESCRIPTION
CDMA RECEIVING DEVICE

Technical Field

5   The present invention relates to a CDMA receiving device, and more particularly to an estimation of interference noise power in the CDMA receiving device.

Background Art

10   In a receiving device using a CDMA (code division multiple access) communication technique, a signal power of a received signal and an interference noise power for each finger are estimated, and the signal-power-to-interference-noise-power ratio (SINR) estimated thereby is used as a weighting factor for the maximum ratio

15   combining of a demodulated signal.   The decrease of an SINR estimation accuracy deteriorates the accuracy of the maximum ratio combining and causes receiving characteristics to be deteriorated. Accordingly, it is necessary to improve the estimation accuracies of the signal power and the interference noise power.

20   The signal power and the interference noise power are normally estimated at a constant period, for example, at each increment of slot.   Since a limited measurement interval, such as determined by a pilot signal, is generally used, the estimation accuracies of the signal power and the interference noise power in one

25   slot are low.   As a method for improving the estimation accuracies of

the signal power and the interference noise power, there is a technique for averaging the estimated values each obtained in one slot among a plurality of slots.

However, as described in "a method for estimating high
5 accuracy channel using a plurality of pilot blocks in DS-CDMA" written by Ando and Sawahashi (The Institute of Electronics, Information and Communication Engineers Technical Report, RCS96-72, 1996) (hereinafter referred to as a "document 1"), the improvement in the estimation accuracy by inter-slot averaging in the
10 signal power is limited. This is because the fluctuation of the signal power with respect to time due to Rayleigh fading is significantly large to thereby lower the fading tracking capability, although the interference noise components included in the received signal are suppressed by the inter-slot averaging.

15 On the other hand, since the interference noise power is substantially constant with respect to time, an effect of improving the estimation accuracy of the interference noise power by the inter-slot averaging processing is large. The present invention is aimed at raising the SINR estimation accuracy by improving the estimation
20 accuracy of the interference noise power and at preventing the characteristic deterioration of the CDMA receiving device.

Fig. 8 shows an example of the receiving device configured to averaging and estimating the interference noise power among a plurality of slots, such as described in "Examination of Method for
25 Measuring SIR under Adaptive Transmission Power Control of

DS-CDMA" written by Seio, Okumura and Doi (The Institute of Electronics, Information and Communication Engineers Society meeting B-330) (hereinafter referred to as a "document 2"). In FIG. 8, interference noise power estimated of one slot before is stored in a

5 one-slot-before interference-noise-power memory 809. Interference noise power 807-n calculated in the current slot and interference noise power 810-n estimated one slot before are averaged by an interference-noise-power inter-slot averaging circuit 808-n.

However, if the interference noise power becomes valid,

10 immediately after the receiving device establishes a radio link to a transmitting device, or after the finger once becomes an invalid state, the estimated value for the one-slot-before interference noise power does not exist. It is to be noted that the recitation "finger is valid" means the state that synchronization timing is detected for the finger.

15 Similarly, the recitation "finger is invalid" means the state that the synchronization timing is not detected for the finger.

In FIG. 8, if there is no estimated value for the interference noise power of one slot before, the one-slot-before interference-noise-power memory 809 does not store therein the

20 interference noise power. At this time, the interference-noise-power inter-slot averaging circuit 808-n performs averaging processing between "0" and the current in-slot interference noise power 807-n. Therefore, if there is no estimated value for the interference noise power of one slot before, the interference-noise-power inter-slot

25 averaging circuit 808-n outputs an interference noise power 811-n

having a low estimation accuracy to an SINR calculation circuit 814. As a result, the estimation accuracy of the SINR is lowered, and the accuracy for the maximum ratio combining of the demodulated signals is deteriorated, thereby causing the characteristics of the

5   CDMA receiving device to be deteriorated.

Disclosure of the Invention

Accordingly, it is an object of the present invention to provide a CDMA receiving device which is capable of preventing

10   deterioration of the receiving quality by accurately estimating interference noise power even if there is no estimated value for the interference noise power of one slot before.

The present invention provides a CDMA receiving device for estimating a signal power and an interference noise power of a

15   received signal for each of fingers, and combining a demodulated signal by using a signal-power-to-interference-noise-power ratio estimated from these estimated signal power and interference noise power, characterized by interference-noise-power calculation means for estimating an interference noise power for each of fingers in a

20   current slot; storage means for storing therein an estimated value for the interference noise power estimated for each of fingers in a last valid slot before a current slot; first averaging means for averaging an estimated value for the interference noise power in a current slot estimated by the interference-noise-power calculation means and the

25   estimated value for the interference noise power stored in the storage

means, first judging means for judging in which slot each finger becomes valid after a radio link is established, and first switching means for storing the interference noise power in a current slot estimated by the interference noise power calculation means into the

5 storage means based on a judged result by the first judging means.

According to the CDMA receiving device of the present invention, even if there is no estimated value for the interference noise power of one slot before, the deterioration of the receiving quality can be prevented by accurately estimating the interference noise power.

10 The present invention realizes the CDMA (code division multiple access) receiving device which achieves the improvement in a communication quality by accurately estimating the interference noise power.

15 **Brief Description of the Drawings**

FIG. 1 is a block diagram of a CDMA receiving device according to a first embodiment of the present invention;

FIG. 2 is a block diagram of a CDMA receiving device according to a second embodiment of the present invention;

20 FIG. 3 is a block diagram of a CDMA receiving device according to a third embodiment of the present invention;

FIG. 4 is a block diagram of a CDMA receiving device according to a fourth embodiment of the present invention;

FIG. 5 is a diagram showing a first estimation example for an

25 interference noise power;

FIG. 6 is a diagram showing a second estimation example for an interference noise power;

FIG. 7 is a diagram showing a third estimation example for an interference noise power; and

FIG. 8 is a block diagram of an example of a conventional receiving device.

Best Mode for Carrying Out the Invention

Prior to the description of the embodiments of the present invention, the principle of the present invention will be described.

Referring to FIG. 1, a CDMA receiving device according to a first embodiment of the present invention is shown. If there is no estimated value for the interference noise power of finger n of one slot before immediately after a radio link is established, a switching circuit 112 is controlled by an in-slot interference-noise-power-output control circuit 115 so that an interference noise power 107-n in the current slot is output to a past-slot interference-noise-power memory 110.

If the interference noise power of one slot before is not estimated and yet there exists an interference noise power which has been once estimated in the past-slot, the past-slot interference-noise-power memory 110 stores therein the last interference noise power which has been valid.

Thus, an inter-slot averaging processing is performed between an interference noise power 111-n output from the past-slot interference-noise-power memory 110 and the estimated value for the

current-slot interference noise power 107-n, and the interference noise power can be accurately estimated.

In the CDMA receiving device according to the above-mentioned embodiment, the SINR can be estimated, even in the state that there is no estimated value for the interference noise power of one slot before, by using the accurately estimated interference noise power. This is achieved by the addition of a configuration for storing the interference noise power in the past-slot interference-noise-power memory 110 for the purpose of inter-slot averaging. Accordingly, the deterioration of the receiving quality can be prevented.

The present invention will be further described below based on the embodiments of the present invention with reference to the accompanying drawings. In FIG. 1, a block for processing a radio band includes an antenna unit 100 for receiving a communication signal, and a radio-signal receiving unit 102 for frequency-converting a radio communication signal into a baseband signal.

A block for despread demodulation of the baseband signal includes N demodulation circuits 104-1 to 104-N. N is a natural number equal to the number of the fingers, and may be any number.

A block for estimating the interference noise power includes N in-slot interference-noise-power calculation circuits 106-1 to 106-N for estimating the interference noise power in the current slot, a past-slot interference-noise-power memory 110 for storing therein the interference noise power estimated in the past slot, and N interference-noise-power inter-slot averaging circuits 108-1 to 108-N

for inter-slot averaging processing between the in-slot interference noise power in the current slot and the interference noise power of the past slot stored in the past-slot interference-noise-power memory 110.

The past-slot interference-noise-power memory 110 overwrites the interference noise power, which is stored up to immediately before, with a new value each time the interference noise power is input. An in-slot interference-noise-power-output control circuit 115 generates an in-slot interference-noise-power-output control signal 116 based on finger-state notification signals 114-1 to 114-N output from the N demodulation circuits 104-1 to 104-N, and outputs the in-slot interference-noise-power-output control signal 116 to the switching circuit 112.

The switching circuit 112 switches the destinations of the current-slot interference noise powers 107-1 to 107-N to be input to the past-slot interference-noise-power memory 110, based on the in-slot interference-noise-power-output control signal 116.

The N signal-power calculation circuits 117-1 to 117-N estimate signal powers 118-1 to 118-N. An SINR calculation circuit 119 calculates N signal-power-to-interference-noise-power ratios (SINRs) 120-1 to 120-N based on interference noise powers 109-1 to 109-N and signal powers 118-1 to 118-N, and outputs the N signal-power-to-interference-noise-power ratios 120-1 to 120-N to a maximum ratio combiner 121. The maximum ratio combiner 121 uses the SINRs 120-1 to 120-N of the respective fingers to weight the demodulated signal to perform the maximum ratio combining, and

outputs the combined signal to a decoding unit 123.

In operation, the frequency of a radio communication signal 101 received by the antenna unit 100 is converted into a baseband frequency band by the radio-signal receiving unit 102. Then,

5 baseband signals 103-1 to 103-N, which are distributed to N corresponding to the number of the fingers, are respectively input to the demodulation circuits 104-1 to 104-N, for despread modulation therein.

As to a finger k (k is a natural number not larger than N) which

10 is in an invalid state at this time, processing is not performed in the stages following the demodulation circuit 104-k. The demodulation circuits 104-1 to 104-N output the finger-state notification signals 114-1 to 114-N for notifying the states of the respective fingers to the in-slot interference-noise-power-output control circuit 115.

15 The demodulated signals 105-1 to 105-N generated for the respective fingers are distributed, and are respectively input to the in-slot interference-noise-power calculation circuits 106-1 to 106-N, the signal-power calculation circuits 117-1 to 117-N and the maximum ratio combiner 121. The interference noise power and the

20 signal power are estimated for the N fingers independently of one another.

The in-slot interference-noise-power calculation circuits 106-1 to 106-N estimate the interference noise powers in the current slot. The in-slot interference noise power can be estimated as the dispersion

25 from the average value of a fading envelope, with the pilot signal as a

measurement interval, as described, for example, in the above-mentioned document 2. However, the process for estimating the in-slot interference noise power may use any technique. The current-slot interference noise powers 107-1 to 107-N are respectively

5   input to the interference-noise-power inter-slot averaging circuits 108-1 to 108-N, and are simultaneously input to the switching circuit 112.

The in-slot interference-noise-power-output control circuit 115 receives the finger-state notification signals 114-1 to 114-N, and

10   outputs the in-slot interference-noise-power-output control signal 116 including control information of each finger. The information of the finger-state notification signals 114-1 to 114-N includes, for example, valid and invalid flags, slot numbers, etc. of the fingers.

The in-slot interference-noise-power-output control circuit 115

15   outputs the in-slot interference-noise-power-output control signal 116 depending upon the finger-state notification signals 114-1 to 114-N. The in-slot interference-noise-power-output control signal 116 includes control information for controlling the switching circuit 112 of each finger, and is output only when the finger is valid.

20   As the in-slot interference-noise-power-output control signal 116, there are two types of signals including ON and OFF. The ON control signal is output only in the slot for the finger to first become valid therein after the radio link is established. The OFF control signal is output otherwise in the slot for the finger being valid therein.

25   Only as to the finger j (j is a natural number not larger than N)

for which the in-slot interference-noise-power-output control signal 116 is ON, the switching circuit 112 outputs the current-slot interference noise power 107-j to the past-slot interference-noise-power memory 110.

5   The interference-noise-power inter-slot averaging circuits 108-1 to 108-N perform the inter-slot averaging processing between the interference noise powers 111-1 to 111-N stored in the past-slot interference-noise-power memory 110 and the current-slot interference noise powers 107-1 to 107-N.   The inter-slot averaging

10   processing is performed by an averaging method using a forgetting factor or a moving average technique.

In the method using the forgetting factor, an interference-noise-power average value NA is calculated as below, wherein λ is the forgetting factor, PRINP is the current-slot

15   interference noise power and PAINP is the past-slot interference noise power:

$$NA = (1 - \lambda) \times PRINP + \lambda \times PAINP$$

The signal power is estimated by the signal-power calculation circuits 117-1 to 117-N, and is output to the SINR calculation circuit

20   119.   As described, for example, in the above-mentioned document 1, the signal power in one slot is estimated by the square of the average value of the fading envelope, with the pilot signal used as the measurement interval, and further the averaging processing can be performed between the slots.   However, the method for estimating

25   may use any technique.

The SINR calculation circuit 119 estimates the signal-power-to-interference-noise-power ratios (SINR) 120-1 to 120-N for the respective fingers by using the input interference noise powers 109-1 to 109-N and the signal powers 118-1 to 118-N, and

5   outputs the signal-power-to-interference-noise-power ratios 120-1 to 120-N to the maximum ratio combiner 121. The maximum ratio combiner 121 uses the SINRs 120-1 to 120-N for the respective fingers as weightings to perform maximum ratio combining of the demodulated signals, and outputs the combined signal 122 to the

10   decoding unit 123.

Hereinafter, to describe the estimation of the interference noise power in more detail, a finger-n which is valid in the current slot will be discussed.

If the interference noise power has been estimated in one slot

15   before by inter-slot averaging in the interference-noise-power inter-slot averaging circuit 108-n, then the inter-slot-averaged interference noise power of one slot before is stored in the past-slot interference-noise-power memory 110. In this case, the inter-slot averaging processing can be performed between the interference noise

20   power in one slot before and in the current slot. The averaged result 109-n is output to the past-slot interference-noise-power memory 110 and the SINR calculation circuit 119.

On the other hand, if the inter-slot average value of the interference noise power has not been estimated before one slot, two

25   cases are conceivable. One is the case immediately after the radio

link is established and the past estimated value for the interference noise power does not exist. In this case, the current-slot interference noise power 107-n is stored in the past-slot interference-noise-power memory 110 by the switching circuit 112 as described above. In this

5 case, the interference-noise-power inter-slot averaging circuits 108-n averages the current-slot interference noise powers with themselves. As a result, the current-slot interference noise power is output to the SINR calculation circuit 119. Such a case is shown in FIG. 5 showing the first estimation example of the interference noise power

10 and its slot number corresponds to a slot M. In this case, the interference noise power estimated according to the present invention is the estimated value for the interference noise power 10 in the slot M.

In another case, the interference noise power has been

15 estimated at least once in the past. The past-slot interference-noise-power memory 110 stores therein the estimated value for the interference noise power in the last slot where the finger n is valid before the current slot. In this case, the interference-noise-power inter-slot averaging circuit 108-n slot

20 performs the inter-slot averaging processing between the slot being valid lastly and the current slot interference noise power.

Such a case is shown in FIG. 6 illustrating the second estimation example of the interference noise power, wherein the subject slot number corresponds to the slot M. In this case, the

25 interference noise power estimated according to the present invention

is an inter-slot average value between the estimated value for the interference noise power 10 in the slot M and the estimated value 13 in the slot M-17.

Referring to FIG. 2, a CDMA receiving device according to a second embodiment of the present invention is shown. The second embodiment is different from the first embodiment shown in FIG. 1 in that a circuit for averaging an interference noise power among fingers is added. The other configuration is similar to that of the first embodiment.

The block for averaging an interference noise power among fingers includes an interference-noise-power inter-finger-averaging control circuit 223, a switching circuit 210, a switching circuit 219, and an interference-noise-power inter-finger averaging circuit 221.

In operation, the interference noise powers 209-1 to 209-N output by N interference-noise-power inter-slot averaging circuits 208-1 to 208-N are bi-split, and input to the switching circuit 210 and the switching circuit 219.

The interference-noise-power inter-finger-averaging control circuit 223 outputs an interference-noise-power inter-finger-averaging control signal 224, used for controlling to which finger the inter-finger averaging processing is performed, to the switching circuit 210 and the switching circuit 219 based on the finger-state notification signals 212-1 to 212-N input from the N demodulation circuits 204-1 to 204-N.

The interference-noise-power inter-finger-averaging control

signal 224 includes control information of the fingers for controlling the switching circuit 210 and the switching circuit 219, and is output only when the finger is valid.

As the interference-noise-power inter-finger-averaging control signal 224, there are two types of signals including ON and OFF. The ON control signal is output when the relevant finger is successively in a valid state for a given period of time, and the OFF control signal is output when the finger is valid except for the previous case. In this case, the valid state must continue long enough to allow the inter-slot averaging processing to be performed for the interference noise power.

A finger k for which the interference-noise-power inter-finger-averaging control signal 224 includes an ON, and a finger m (m is a natural number not larger than N) for which the control signal 224 includes an OFF will be discussed hereinafter. The switching circuit 219 outputs only an interference noise power 220-k to the interference-noise-power inter-finger averaging circuit 221 based on the interference-noise-power inter-finger-averaging control signal 224.

The interference-noise-power inter-finger averaging circuit 221 estimates the inter-finger average 222 of the input interference noise power 220-k, and outputs the inter-finger average 222 to the switching circuit 210. The switching circuit 210 outputs the inter-slot average interference noise power 209-k for the finger k, and outputs the inter-finger average interference noise power 222 for the finger m to

the SINR calculation circuit 227.   However, it is to be noted that if the control signals are OFF for all the fingers, the interference noise powers 209-1 to 209-N are output to the SINR calculation circuit 227.

Hereinafter, in order to describe the operation of this

5 embodiment in more detail, estimation of the interference noise power in the slot M in the example shown by a third estimation example of the interference noise power of FIG. 7 is discussed.   In this case, the interference-noise-power inter-finger-averaging control signal 224 is ON for finger numbers 1 and 3, and is OFF for a finger number 2.

10 Therefore, the interference noise power 211-2 output from the switching circuit 210 is an inter-finger average, 11, of 10 and 12 which are the estimated values for the interference noise powers of the finger numbers 1 and 3 in the slot M.   On the other hand, the interference noise powers 211-1 and 211-3 are 10 and 12,

15 respectively.

According to a second embodiment, even if there is a finger for which the estimated value for the interference noise power does not exist in one slot before, the optimum maximum ratio combining can be performed.   This is because the estimation accuracy of the

20 interference noise power is improved by adding the configuration for inter-finger averaging the interference noise powers of the fingers for which the inter-slot averaging processing is sufficiently performed.

Referring to FIG. 3, a CDMA receiving device according to a third embodiment of the present invention is shown.   The third

25 embodiment is different from the first embodiment in that a circuit is

added in the present embodiment, the circuit using a demodulated signal in the maximum ratio combining after inter-slot averaging processing of an interference noise power is performed for a given period of time, if there is no estimated value for the interference noise

5   power of one slot before.

The added configuration includes a combining-delay control circuit 319, a switching circuit 310, and a switching circuit 326.   The past-slot interference-noise-power memory 110 is replaced by a one-slot-before interference-noise-power memory 317.

10   In this third embodiment, it is not necessary to perform the inter-slot averaging processing by using the past-estimated value unlike the first embodiment.   This is because the interference noise power is sufficiently averaged among the slots and is utilized for the maximum ratio combining if there is no estimated value for the

15   interference noise power of one slot before.

In operation, interference noise powers 309-1 to 309-N output by N interference-noise-power inter-slot averaging circuits 308-1 to 308-N are input to the switching circuit 310.   The demodulated signals 305-1 to 305-N output by N demodulation circuits 304-1 to

20   304-N are input to the switching circuit 326.

The combining-delay control circuit 319 outputs a combining-delay control signal 320 to the switching circuit 310 and the switching circuit 326, for controlling which finger is to be used for the maximum ratio combining based on the finger-state notification

25   signals 312-1 to 312-N input from the demodulation circuits 304-1 to

304-N.

The combining-delay control signal 320 includes control information of each finger for controlling the switching circuit 310 and the switching circuit 326, and outputs only if the relevant finger is

5   valid.   As the combining-delay control signal 320, there are two types of signals including ON and OFF.   The OFF control signal is output until the valid state continues for a given period of time if the finger that was in an invalid state one slot before becomes valid in the current slot.

10   The ON control signal is output after the valid state of the finger is continued for a given period of time.   The ON control signal is successively output unless the relevant finger becomes invalid.   In this case, the valid state must continue long enough to allow the inter-slot averaging processing for the interference noise power to be

15   sufficiently performed.

Here, a certain finger n will be discussed.   When the OFF combining-delay control signal 320 is input to the switching circuit 310, the switching circuit 310 does not output the interference noise power 311-n and the signal power 323-n to the SINR calculation

20   circuit 324.   However, since the interference noise power is input to the one-slot-before interference-noise-power memory 317 and stored therein, the interference noise power can be used for the inter-slot · averaging processing of the interference noise power in the next slot.

Similarly, if the OFF control signal 320 is input to the switching

25   circuit 326, the switching circuit 326 does not output the demodulated

signal 305-n to a maximum ratio combiner 328. Therefore, the finger n is used only for estimating the interference noise power and the signal power while the combining-delay control signal 320 is OFF. At the time when the combining-delay control signal 320 is changed

5 from OFF to ON, the switching circuit 310 outputs the interference noise power 311-n and the signal power 323-n to the SINR calculation circuit 324, wherein the SINR estimating for the relevant finger is started. Simultaneously, the switching circuit 326 outputs the demodulated signal 327-n to the maximum ratio combiner 328, and

10 performs the maximum ratio combining to the demodulated signal based on the estimated SINR 325-n.

According to the third embodiment, even if there is a finger for which the estimated value for the interference noise power does not exist in one slot before, the optimum maximum ratio combining can

15 be performed. The reason is that the accurate interference noise power can be used at any time for the maximum ratio combining by adding the configuration for not performing the maximum ratio combining for the finger until the interference noise power is sufficiently averaged among the slots.

20 Referring to FIG. 4, a CDMA receiving device according to a fourth embodiment of the present invention is shown. The fourth embodiment is different from the first embodiment in that a finger dedicated to the interference noise power calculation is provided.

A portion for estimating the interference noise power by using

25 the finger dedicated to calculating the interference noise power

includes an

interference-noise-power-calculation-dedicated-finger-output control

circuit 419, a switching circuit 416, an

interference-noise-power-calculation-dedicated-demodulation circuit

5   410, an in-slot interference-noise-power calculation circuit 412, and an

interference-noise-power inter-slot averaging circuit 414.

Further, the past-slot interference-noise-power memory 110 is

replaced by a one-slot-before interference-noise-power memory 425.

This is because an accurate interference noise power, which is

10   estimated by the interference-noise-power-calculation-dedicated

finger, can be used for the SINR estimation when there is no

interference noise power of one slot before, without performing the

inter-slot averaging using the interference noise power of the past-slot,

unlike the first embodiment.

15   In operation, the baseband signal output by the radio-signal

receiving unit 402 is distributed to (N+1).   This is because the

baseband signal is distributed to the

interference-noise-power-calculation-dedicated finger in addition to N

fingers for demodulating the received signal.   The baseband signals

20   403-1 to 403-(N+1) are input to N demodulation circuits 404-1 to

404-N and the interference-noise-power-calculation-dedicated

demodulation circuit 410.

The interference-noise-power-calculation-dedicated

demodulation circuit 410 performs despread demodulation for the

25   baseband signal 403-(N+1) based on an arbitrary synchronization

timing determined for this purpose.   Therefore, in the ·
interference-noise-power-calculation-dedicated finger, there occurs no
case where the demodulation is not performed due to the reason that
the synchronization timing cannot be detected, and thus stays in the

5   valid state at any time.

Accordingly, the interference noise power estimated by the
interference-noise-power-calculation-dedicated finger is accurately
estimated due to the inter-slot averaging performed at any time.   The
in-slot interference-noise-power calculation circuit 412 estimates the

10   interference noise power in the current slot from the demodulated
signal 411 demodulated by the
interference-noise-power-calculation-dedicated demodulation circuit
410, and the inter-slot averaging processing of the interference noise
power is performed by the interference noise power averaging circuit

15   414.   An interference-noise-power inter-slot average value 415 is
stored in the one-slot-before interference-noise-power memory 425
similarly to the interference noise power estimation processing for the
fingers except the interference-noise-power-calculation-dedicated
finger, and is used for the inter-slot averaging processing in the next

20   slot.

An interference-noise-power-calculation-dedicated-finger-output
control circuit 419 outputs an
interference-noise-power-calculation-dedicated-finger-output control
signal 420, which is used for controlling for which finger the SINR

25   estimation is performed by using the interference noise power

estimated by the interference-noise-power-calculation-dedicated
finger based on the finger-state notification signals 418-1 to 481-N
input from the N demodulation circuits 404-1 to 404-N, to the
switching circuit 416.

5   The
interference-noise-power-calculation-dedicated-finger-output control
signal 420 includes control information of each finger for controlling
the switching circuit 416, and outputs only when the relevant finger is
valid.   The
10   interference-noise-power-calculation-dedicated-finger-output control
signal 420 includes two types of signals including ON and OFF.   The
ON control signal is output if the finger is successively in a valid state
for a given period of time, and the OFF control signal is output when
the finger is valid except for the previous case.   In this case, the valid
15   state must continue long enough to allow the inter-slot averaging
processing to be performed for the interference noise power.

Hereinafter, a finger k for which the
interference-noise-power-calculation-dedicated-finger-output control
signal 420 includes an ON, and a finger m for which the control signal
20   420 includes an OFF will be discussed.   The switching circuit 416
outputs an interference noise power 415 estimated by the
interference-noise-power-calculation-dedicated finger to an SINR·
calculation circuit 430 for an interference noise power 471-m.   On
the other hand, as to the interference noise power 417k, an
25   interference noise power 409-k, which is inter-slot averaged by a

finger k, is output to the SINR calculation circuit 430.

According to a fourth embodiment, even if there is a finger for which the estimated value for the interference noise power does not exist in one slot before, the optimum maximum ratio combining can

5   be performed.   The reason is that the estimation accuracy of the interference noise power is improved by adding the configuration for performing the inter-slot averaging processing at any time in the interference-noise-power-calculation-dedicated finger.

As described above, the CDMA receiving device according to

10   the present invention can prevent the deterioration of receiving quality by accurately estimating the interference noise power even if there is no estimated value for the interference noise power of one slot before.

According to the present invention, even if there is no estimated value for the interference noise power of one slot before, such as,

15   immediately after the radio link is established, or in the case where the finger is again validated after the finger is once invalidated, the optimum maximum ratio combining can be performed.   The reason is that the estimation accuracy of the interference noise power is improved by adding the configuration for storing at any time the

20   interference noise power, which is an object for performing the inter-slot averaging processing, in the past-slot interference-noise-power memory 110.